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Innovation to Motivation - Pilot study of a mobile phone intervention to increase physical activity among sedentary women

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Abstract

Objectives—This uncontrolled pilot study assessed changes in pedometer-measured step counts and self-reported physical activity during a three-week mobile phone-based intervention. We also explored whether age, BMI, and psychosocial factors were associated with changes in step counts.

Methods—Forty-one sedentary adult women in San Francisco California were asked to report their pedometer steps using a study-supplied mobile phone from June to September 2008. In the second and third weeks, daily prompts delivered by the mobile phone encouraged participants to increase steps by 20% from the previous week.

Results—Mean age was 48 years. Average daily total steps increased by approximately 800 or 15% over three weeks ($p < 0.001$). Lower BMI, no antidepressant use, and lower self-reported health status were associated with higher step counts at baseline. Improvements in self-reported will-power were associated with increases in step counts ($p < 0.001$). Neither age ($p=0.55$) nor BMI ($p=0.13$) was significantly associated with changes in activity over the three weeks.

Conclusions—The intervention appeared to motivate sedentary women to increase their physical activity. A randomized controlled clinical trial is warranted and feasible.

INTRODUCTION

Half of adults in the United States do not engage in recommended levels of physical activity, despite established health benefits, and women are less likely to achieve recommended levels

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than men (Healthy People 2010). Communication technologies that can reach large numbers are readily available, but we need to understand how to use them most effectively. In particular, better information is needed on how these interventions can be used to promote physical activity among sedentary women. We conducted an uncontrolled pilot study to examine potential efficacy of a three-week mobile phone intervention. We measured changes in pedometer-measured step counts and self-reported physical activity, and assessed the associations of these changes with age and baseline weight, as well as with concurrent changes in self-efficacy, social support, and barriers to being physically active.

METHODS

Study design and sample

Participants were recruited from the San Francisco Bay area. Study inclusion criteria were: 1) age 25–70 years, 2) female gender, 3) ability to access a telephone at home and/or a mobile phone, and 4) having a sedentary lifestyle screened by the Stanford Brief Physical Activity Survey (Taylor-Piliae et al., 2006). Exclusion criteria were: 1) known medical conditions or other physical problems requiring special attention in an exercise program, 2) severe hearing or speech problems, and 3) current participation in lifestyle modification programs or research studies. Seventy-eight women were screened by phone and given information about the study, including the requirement for daily mobile phone and pedometer use. Of these, 47 women visited the research office for further screening. Five did not meet all inclusion criteria and one declined. The study was approved by the University of California San Francisco Institutional Review Board.

Procedures and intervention

After obtaining written consent, we provided a MOTORAZRv3xx mobile phone installed with the physical activity program to all participants during the three-week study period. All participants were shown how to wear the pedometer, respond to daily prompts, and use the mobile physical activity diary. Participants were asked to wear a pedometer for three weeks, and to send their total number of steps via mobile phone before going to bed. Participants were able to access the mobile phone diary only after 7 pm to midnight in order to prevent back-or-forward filling of data. The mobile phone diary program was designed such that subjects had to answer every question in a sequential manner. For example, when a woman selected “diary,” she would see the first question, “Did you wear a pedometer all day today, except for showering, swimming, sleeping?” If the answer was “yes”, they were asked to enter the number of steps in a box.

Compliance to the diary was 88.3% (Fukuoka Y et al., In print). In the second and third weeks, women were asked to increase their steps by 20% from the previous week. Weekly goals based on self-reported steps were relayed by the mobile phone, along with immediate feedback and motivational messaging. Prompts regarding the benefit of physical activity, barriers to increasing physical activity, and social support for physical activity were also sent daily to each participant, followed by relevant questions. For example, women received the following daily prompt from the researcher: “Getting support is one of the most important things you can do when becoming more active. Do you have someone who could be your support or be active with you today?” Women needed to select “no” or “yes” by pushing the keypad. If a woman selected “no”, the next screen displayed “Find at least two people you can contact this week who will help keep track of your activity for reaching your goals.” Response to the daily prompt was 85.3%. Step counts were measured using the **Omron HJ-720ITC Pedometer**, which can store step counts and aerobic movement for 41 days (Holbrook et al., 2009). Overall compliance in wearing a pedometer over three weeks was 93.8% (Fukuoka Y, et al., In print). Since each participant had a total of 21 days to comply with diary, prompts, diary, and pedometer use,

compliance was defined as the total number of days used divided by 21 days. At the baseline and end of study visit, the **7-day Physical Activity Recall (7-day PAR)** was used to assess self-reported physical activities during the week (Sallis et al., 1985). In addition, we used the **Self-Efficacy for Physical Activity Survey (SEPA)** to measure how confident the participant was about engaging in physical activity (Marcus et al., 1992). We also used the **Barriers to Being Active Quiz (BBAQ)** to assess (1) lack of time, (2) social influence, (3) lack of energy, (4) lack of willpower, (5) fear of injury, (6) lack of skill, and (7) lack of resources (Centers for Disease Control and Prevention (CDC). 2008). The **Social Support and Exercise Survey (SSES)** was used to social support from friends and family during the past three months (Sallis et al., 1987). Finally, **overall health status** was assessed on a 7-point scale from very poor to excellent. Participants' weight and height were measured by the researcher.

Statistical analysis

We used paired t-tests to assess changes in PAR, SEPA, BBAQ, and SSES scores. Mixed linear models were used to estimate average changes in reported daily total and aerobic steps, and to assess the associations of physical activity with age and BMI, as well as SEPA, BBAQ, and SSES scores. Aside from age, predictors in the final mixed model were selected using backward deletion with a retention criterion of $p < 0.10$. All analyses were conducted using Stata Version 11 (Stata Corp, College Station, TX).

RESULTS

Mean age was 48 (range 25–70). Fifty-nine percent of women were minorities, 51% had never been married, and 51% were employed. Mean BMI was 33 kg/m^2 ($\text{SD} \pm 10.0$). Although the mean self-rated general health score was 4.6 out of 7, 22% of women were taking antidepressants. Most (88%) had used a mobile phone at least once a week during the month prior to enrollment.

All 41 women completed data entry of daily physical activity for the 3-week period and attended the second research visit. Average daily total and aerobic steps both increased substantially across the three weeks (Table 1.1). In addition, average daily caloric expenditure increased (Table 1.2). And while average self-efficacy (SEPA), overall barriers (BBAQ), and social support (SSES) scores were similar at baseline and follow-up, the barriers to activity (BBAQ) subscale measuring will-power improved ($p = < 0.001$).

Average daily total steps at baseline were lower among women on antidepressants as well as among women with higher BMI and those with better self-rated health (Table 2). However, the improvements in will-power shown in Table 2 were strongly associated with increases in average daily total steps ($p < .001$). Of note, week was no longer a statistically significant predictor of daily total steps after adjustment for increases in will-power ($p = 0.58$).

DISCUSSION

Among 41 women in our pilot study of a mobile phone intervention to increase physical activity, average daily total and aerobic steps as well as caloric expenditure improved over three weeks. Although there is individual variability, an increase of approximately 800 steps per day is generally equivalent to an additional 8 to 10 minutes of physical activity (Marshall et al., 2009). It is also important to note that these increases in step counts do not reflect other activities such as swimming and bicycling. At baseline we found lower physical activity among women with higher BMI and anti-depressant users, but also among women with higher self-rated general health. Increases in physical activity were not associated with any baseline characteristics we measured, but were strongly associated with improvements in self-reported will-power.

Lower baseline levels of physical activity among women with depression or higher BMI have been previously reported (McKercher et al., 2009). A possible explanation for the unexpected inverse association between self-reported general health and physical activity is that participants in worse health are more motivated to improve it by exercising. Although we expected bigger increases in physical activity among younger and thinner women, we found no evidence for this. The association of increases in activity with improvements in self-reported will-power suggests that enhancing participant motivation is a key component of our intervention. In contrast, while previous reports have consistently identified improvements in self-efficacy as a mediator of treatment effects on physical activity (Shephard, 2002), self-efficacy did not significantly improve, nor were changes in this factor associated with increases in physical activity. We do not have a clear explanation of this finding. However, since the duration of the intervention in this pilot study was short, a longer, scaled-up mobile phone-based intervention may improve self-efficacy, potentially enhancing responses to the intervention. Similarly, previous reports showing the importance of social support from family and friends (Eyler et al., 1999) in particular among sedentary women, were not reflected in our results. Modifications to the intervention may be required to help women obtain more social support.

Several limitations need to be taken into account. First, in this small pilot study with no control group, we could not estimate the efficacy of the intervention, nor definitively evaluate moderators or mediators of intervention effects. Second, the study was short, with a small sample size, so it may not fully reflect the effects of a longer intervention or have detected factors associated with its potential benefits. Third, the study involved only sedentary women, so results may not be generalizable to sedentary men or children.

Conclusions

The mobile phone-based intervention appeared to motivate sedentary women to increase their physical activity. A randomized controlled trial of this intervention is warranted and feasible.

Acknowledgments

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Table 1

Changes in Physical Activity and Psychosocial Scores

1.1. Changes in Average Total and Aerobic Steps over three week (pedometer measured)					
Outcomes	Week	Average	95 % CI:	P-value*	P-value**
Total Steps	1	5394	4563–6224	ref	0.001
	2	5750	4920–6580	0.130	
	3	6210	5379–7041	0.001	
Aerobic Steps	1	953	489–1416	ref	<0.001
	2	1302	841–1763	0.03	
	3	1535	1074–1996	<0.001	

1.2. Changes in 7-day Physical Activity Recall Questionnaire and psycho-social scores			
Predictor	Baseline Mean (±SD)	Follow-up Mean (±SD)	P-value
PAR (Kcal/kg/day) [‡]	32.5 (1.28)	33.4 (1.99)	0.008
SEPA	11.5 (3.72)	11.8 (3.94)	0.57
BBAQ: overall [‡]	25.8 (11.93)	23.2 (12.07)	0.11
BBAQ subscales: [‡]			
Lack of time	3.1 (2.71)	3.3 (2.76)	0.62
Social influence	4.5 (2.64)	4.1 (2.32)	0.18
Lack of energy	3.6 (2.85)	3.7 (2.76)	0.81
Lack of willpower	7.3 (2.13)	5.3 (2.70)	<0.001
Fear of injury	1.7 (1.62)	1.6 (1.75)	0.91
Lack of skill	2.9 (2.59)	2.5 (2.36)	0.08
Lack of resources	2.9 (2.50)	2.8 (2.44)	0.88
SSES: family	24.7 (10.6)	26.7 (12.3)	0.27
SSES: friends	27.1 (9.3)	28.3 (11.0)	0.51

* P-value for contrast with week 1

** P-value for trend across weeks

[‡] 2 subjects participated in swimming activities, 2 subjects participated in yoga , and 4 subjects participated in cycling activities during the study period.

[‡] Higher scores indicate higher barriers to be physically active. PAR=7-day Physical Activity Recall Questionnaire, SEPA=Self-Efficacy for Physical Activity, BBAQ=Barriers to Being Active Quiz, SSES=Social Support And Exercise Survey

Table 2

Predictors of average daily total steps across the three weeks (number of observations = 530 in N=41)

Predictors	Effect	95% CI	P-value
Week	80	−204, 365	.58
Age (per 10 years) [#]	−26	−591, 539	.93
BMI (per 5 kg/m ²) [#]	−547	−936, −159	.007
Anti-depressant use [@]	−1900	−3582, −217	.027
Self-rated general health [@]	−1099	−1793, −405	.002
Baseline will-power [@]	−245	−555, 65	.12
Improvement in will-power [%]	−344	−518, −171	<.001

Week and age were included in the model for face validity.

Interactions between these factors and week were examined but dropped from the model (both $p > 0.1$)

[#] Use or non-use of mobile phones by study participants prior to the study enrollment did not predict changes in step counts ($p = 0.66$)

[@] Coefficients for these baseline factors measure their associations with baseline step counts

[%] Coefficient for this time-dependent factor measures its association with change in step counts